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What You Should Know About Farm Water Supplies in Alberta. 1
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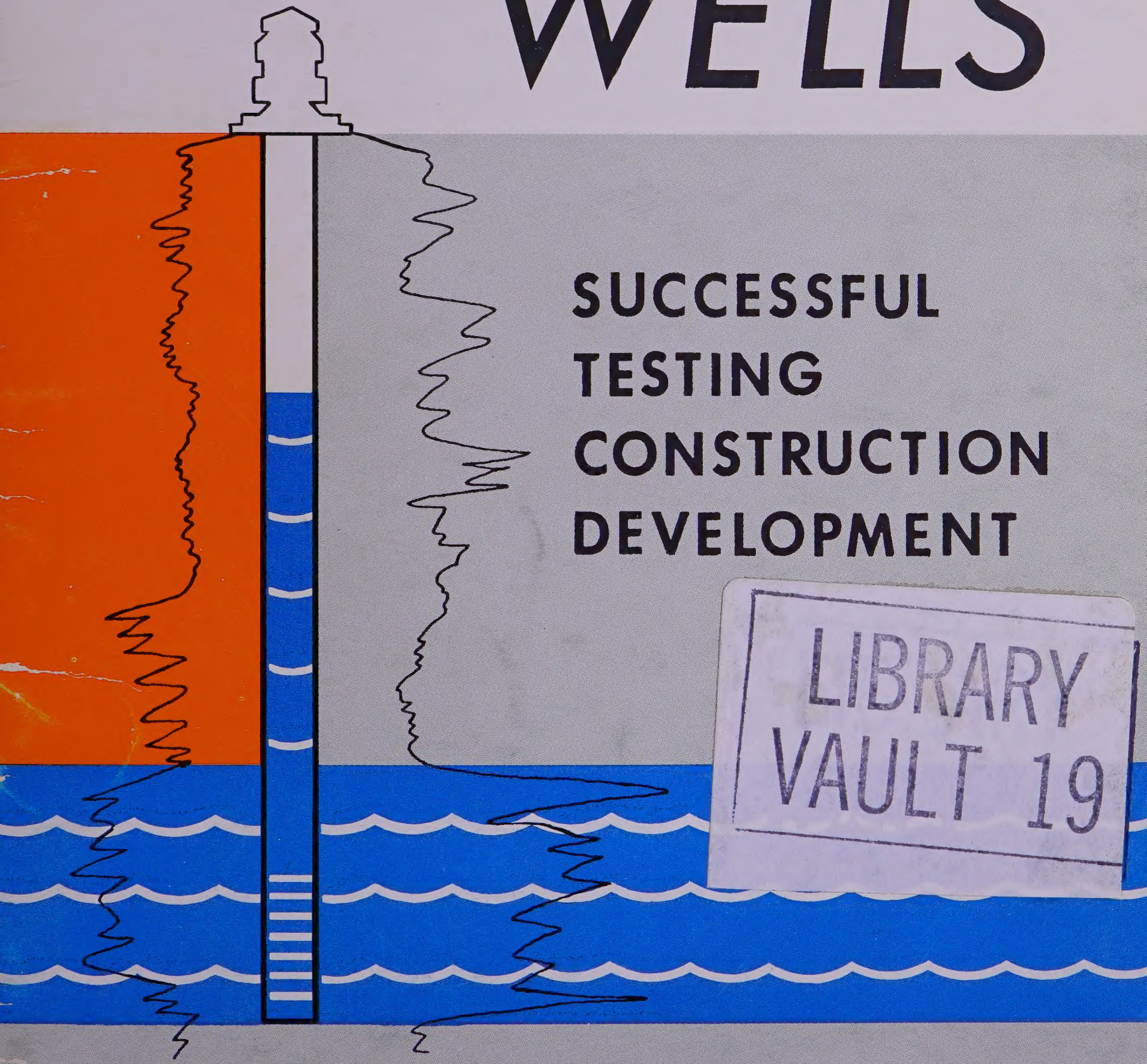
FARM WATER WELLS



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PROVINCE OF ALBERTA
DEPARTMENT of AGRICULTURE

HON. HARRY E. STROM
MINISTER

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WHAT YOU SHOULD KNOW ABOUT FARM WATER SUPPLIES IN ALBERTA

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PREPARED BY THE GROUNDWATER SECTION OF THE
WATER RESOURCES DIVISION, DEPARTMENT OF AGRICULTURE
1965

HON. HARRY E. STROM
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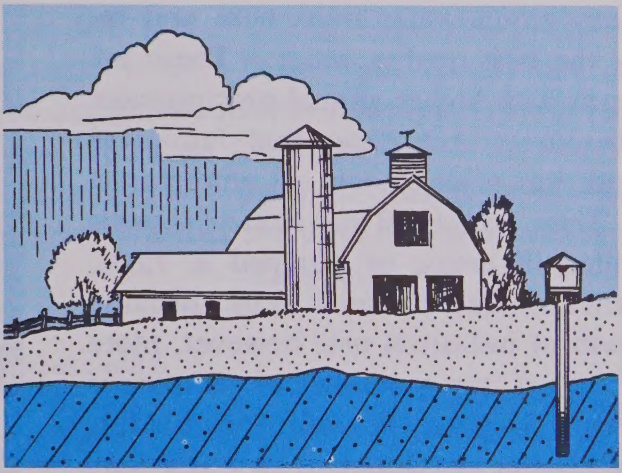
Introduction

Water is one of the most useful and valuable resources on earth. Fortunately, it is extremely abundant, and makes up the major part of all living things.

The most obvious sources of water on the prairies are our lakes and streams. They have some serious drawbacks as farm water supplies however, such as hauling costs, algae, dirty color and danger of pollution.

Less obvious is the water underneath our feet in the ground. Being hidden, it is considered somewhat mysterious by many people. Yet groundwater, as it is called, has many advantages over other resources: freedom from contamination, local availability, and low constant temperature.

THE ABUNDANCE OF WATER IN THE GROUND

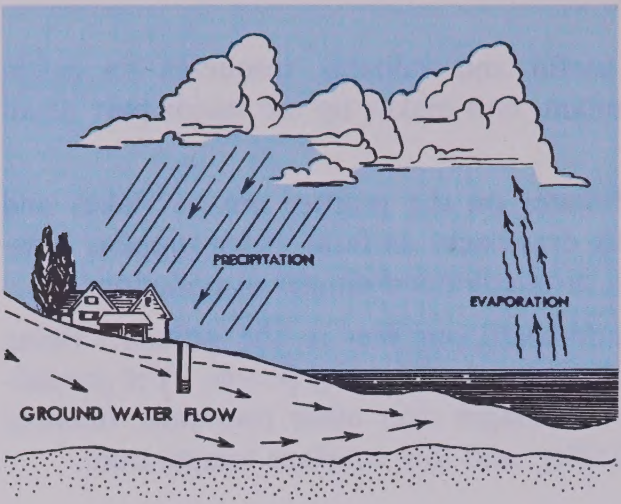


Several government agencies are extremely interested in the development of ground water supplies for the people of Alberta, in locating water reserves, protecting them from depletion, and preventing their contamination. This booklet was written to help Alberta farmers locate and utilize good groundwater supplies.

What Is Groundwater?

Groundwater is just one phase of the water cycle: when rain, snow or sleet falls, part eventually evaporates back into the atmosphere, part runs off into streams, part is held by the soil for plant use, and a small amount infiltrates down to the water table. That which reaches the water table is termed ‘groundwater’. Water below the water table moves very slowly, from a few feet per year to a few feet per day. It ultimately reappears at the surface in some low area, such as a perennial slough, lakeshore, river bank or the sea shore. Springs and flowing wells are places where water issues from the earth in a visible flow.

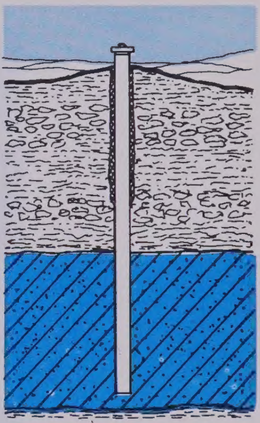
NATURE'S WATER CYCLE



After the water returns to rivers, lakes and oceans, it evaporates, then reappears as rainfall once again, forming an endless cycle.

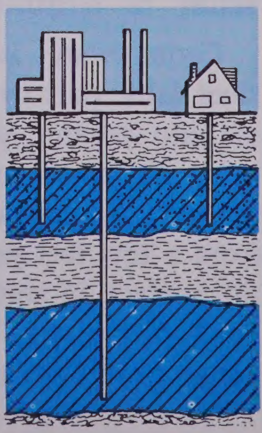
It has been found that about two to three percent of the annual precipitation reaches the water table in Alberta. Where satisfactory underground reservoirs exist, up to this amount of water can be removed each year with no fear of depletion.

The longer the time that the water has been in the earth, the more highly mineralized it becomes. Hence the areas of maximum groundwater movement and recharge will have the best quality water. These are the more hilly areas with higher annual precipitation.



Above — A water-table well penetrates a porous formation in which only the lower portion is completely saturated with ground water.

Below — An artesian well taps a porous formation that is completely full of water and in which the water is confined under pressure by an overlying impervious layer such as clay.



The Water Resources Act states that farm and domestic water use has priority over all other forms of consumption. Thus, municipal and industrial wells can only be drilled in areas, or pumped at rates, which do not harm farm and domestic wells. Because of the rapid growth of industrial use, however, more careful management of our groundwater reserves is becoming necessary. This may necessitate forbidding any further groundwater development in a few very restricted areas.

A water well is any hole dug into the earth which reaches the water table for the purpose of extracting water. Strictly speaking, a dugout which intersects the water table is therefore a well. Generally, however, we think of wells as being a few inches to a few feet in diameter.

No drilled farm well should be less than four inches in diameter, because smaller ones seriously limit production and make repairs and servicing very difficult. Above this minimum size, doubling the diameter only increases well yield by eleven to twenty-five percent. Hence, for the quantities of water needed by most farmers, a well should rarely need to be over six inches in diameter.

Wells are drilled into two types of aquifers: water table and artesian. A water table well penetrates an aquifer whose lower surface is a relatively impermeable confining bed, and whose upper surface is the water table itself. When pumping lowers the water level of the well, the water table drops in its vicinity.

An artesian well does not necessarily flow, contrary to popular thought. It penetrates an aquifer whose upper and lower boundaries are both confining beds. The water level in the well itself rises somewhat higher than the top of the upper confining bed, and if it rises higher than land elevation the well will flow. During pumping, the aquifer remains completely saturated and the drop in water level in the well is purely a result of declining pressure in the aquifer.

Water table wells are usually shallow and more susceptible to contamination. Some will dry up from time to time. However, their yield is frequently greater than from artesian wells.

How Much Water Do You Need?

It is possible to drill a well almost anywhere in the farming areas of Alberta and get some water. It may not always be found in adequate quantities or be of acceptable quality however. This is particularly true in eastern Alberta and the Peace River district.

The following table will help the individual assess his own water requirements, so he will know whether the yield of a new well is sufficient.

	Requirement (gallons per day)
Holstein calves (4 weeks old)	2
Holstein calves (12 wks. old)	3
Holstein calves (16 wks. old)	4
Holstein calves (20 wks. old)	4
Holstein calves (26 wks. old)	5
Steers (maintenance ration)	4
Steers (fattening ration)	8
Range cattle	12
Jersey milk cows	20
Holstein milk cows	28
Holstein milk cows — dry	12
Poultry (1 to 3 wks. old) (per 100 birds)	0.4 to 2.0
Poultry (3 to 6 wks. old) (per 100 birds)	1.1 to 2.4
Poultry (6 to 10 wks. old) (per 100 birds)	2.4 to 3.2
Poultry (9 to 13 wks. old) (per 100 birds)	3.2 to 4.0
Pullets (per 100 birds)	2.4 to 3.2
Non-laying hens (per 100 birds)	4.0
Laying hens (per 100 birds)	4.0 to 6.0
Swine	4
Sheep	2
Farmhouse, with pressure system (per person)	50

To estimate your daily requirements, total up the amount of water for all animals and people using your well. Since drillers usually measure well yield in gallons per minute, not gallons per day, divide the total by 1,440 to calculate your need in gallons per minute.

How Do You Select a Competent Driller?

Well drilling, like farming, is no job for amateurs, and only the professional licensed driller will be capable of giving you the best possible well.

In order to keep abreast of developments in his industry, the competent driller will be a member of the Alberta Water Well Drillers Association. He is listed in the Yellow Pages of your telephone directory, and will have a good reputation among his suppliers and previous clients. His equipment will be modern and in good repair.

Insist that the prospective contractor:

1. Make a written contract for protection of both parties.
2. Carry adequate insurance coverage.
3. Disclose his charges on an itemized basis, not just 'per-foot'.
4. Be a licensed driller, not a 'fly-by-night' operator. Your district agriculturist has a list of all drillers licensed in Alberta.
5. Provide you with a log of all earth materials encountered, depth of well, depth to water, length and diameter of casing, completion details, etc. This is essential if the well ever needs servicing, and is required by law for the well owner's benefit.
6. Cement the well at the top to prevent contamination.
7. Guarantee the quality of his workmanship and materials for one year.
   No driller will guarantee to find water however, because there are some places where it is just not possible.

Which Type of Drill is Best?

This is a difficult question to answer because the answer depends to a great extent on what type of material is to be drilled.

The cable tool rig is operated by repeatedly raising and dropping a heavy tool or bit at the end of a cable or rope. When the tool hits the earth, it gradually pounds a hole into the ground. Usually a little water is poured into the hole to facilitate the cutting action of the bit. Every few feet, another tool called a bailer is used to remove the cuttings. The casing is often driven simultaneously with drilling. The cable tool rig can drill through almost anything, given enough time, and is considered cheaper than the rotary method. No drilling mud is caked on the wall of the well, so nothing can impede the flow of water into it from the earth.

Rotary rigs drill by means of a cutting bit which is rotated at the bottom of the hole. Drilling mud or water is forced down the drillstem and through the bit to carry the cuttings up to the surface. Casing must be placed after drilling is completed. Rotary rigs are therefore ineffective in coarse gravel, because the gravel may cave during drilling or before the casing is set in place. The bit tends to slide on boulders, rather than cutting through them. In very fine sand or sandstone, the pressure of the drilling mud is likely to seal off any water that may be present. This method is faster, however, and more adapted to developing a well to its maximum capacity once drilling is complete.

Boring machines drill a well which is from two to four feet or more in diameter. Such wells are necessary in low porosity material, where the well-bore acts as a reservoir to collect water. Bored wells are not commonly used except in these circumstances.

Dug wells and driven sand points are not recommended. They cannot be dug or driven to any great depth, are easily contaminated and usually have low yields.

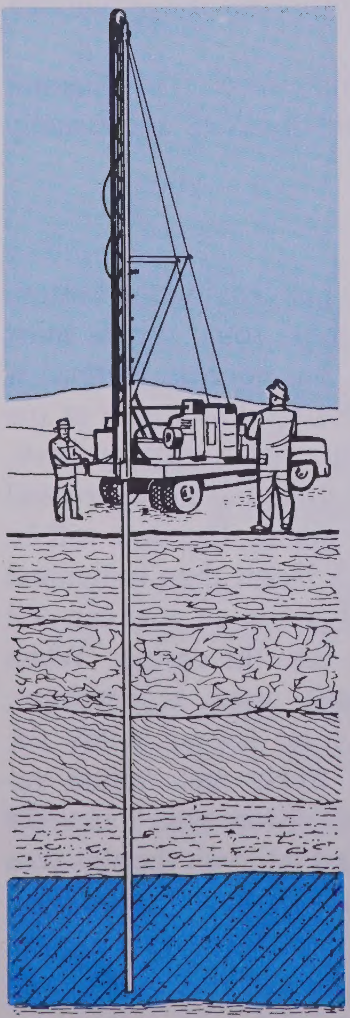
Well Screens and Sand Packs

A well may be completed in a hard formation by just leaving the bottom part uncased. If the formation tends to cave however, some means must be used to hold the well bore open. The cheapest, but poorest, method is to slot the lower part of the casing with a cutting torch, then drive the casing to total well depth. The slots will be much larger than individual sand grains, so sand can still pass into the casing. When enough sand accumulates, water no longer enters the well freely and failure results. Moreover, in the slotted interval, the slot area is seldom over five percent of total casing area. Therefore, the slotted casing keeps out much more water than it lets in.

The best means of constructing a successful well in caving materials such as soft sandstone, gravel, or sand, is to install a well screen. These screens may be purchased in any standard length or diameter, and slot size is selected on the basis of an analysis of the actual sand or gravel sample. Such screens are constructed of stainless steel, and should last a lifetime. Their open area is between fifteen and twenty-five percent, which has been found to be the maximum open area necessary for maximum water yield.

Sometimes a sand is encountered which is finer than the smallest slot-size available. In such cases, a layer of a special selected coarser sand is placed between the screen and the aquifer. This permits water to pass, but keeps the fine sand out. This is called a sand pack, or gravel pack.

Once the screen (and sand pack, if necessary) are installed, the well is pumped and otherwise treated to remove the finest sand immediately adjacent to the screen leaving a coarser filter zone around it. This is called development. When development is complete, the sand is progressively coarser approaching the screen. Thus a maximum amount of water is free to pass into the well, but sand grains are effectively held back. The proper development of a well is an important step to insure continued satisfactory performance.



Where Do You Find Water?

In the farming areas of Alberta, the land surface consists mainly of till, that is, clay mixed with sand and gravel. This till, which was deposited during the glacial period, varies in thickness from a few feet to several hundreds of feet. Gravel and sand lenses encountered in the till will yield modest amounts of water. Buried beneath the till are ancient river channels which were covered by the glaciers. These channels are often gravel bearing and may offer excellent prospects for water supplies. The Groundwater Division of the Alberta Research Council, Edmonton, has mapped many of these channels and publishes reports on their locations. In addition to their publications, they will supply detailed information about local areas upon request.

Below the glacial till and buried river channels is a thick sequence of alternating shale and sandstone layers. In eastern Alberta and the Peace River district, it is predominantly shale, with very little sandstone. Sufficient water for a farm supply can be obtained from the sandstone beds usually, with the shale between acting as a barrier to water movement.

In selecting the site for your well, convenience of access should be considered. Also, remember that wells in low areas do not have to be as deep as those on knolls. Avoid drilling downslope from, or near barns, privies, or septic tanks. These fixtures can readily pollute a water supply. Assuring the purity of well water should be the most important consideration in selecting the well location.

Regarding the all too common practice of 'witching' for water, we can best quote the late Dr. O. E. Meinzer, of the United States Geological Survey:

'It is doubtful whether so much investigation and discussion have been bestowed on any other subject with such absolute lack of positive results. It is difficult to see how for practical purposes the entire matter could be more thoroughly discredited, and it should be obvious to everyone that further tests by the United States Geological Survey of this so-called 'witching' for water, oil, or other minerals would be a misuse of public funds.

It is by no means true that all persons using a forked twig or some other device for locating water or other mineral are intentional deceivers. Some of them are doubtless men of good character and benevolent intentions. However, as anything that can be deeply veiled in mystery affords a good opportunity for swindlers, there can be no reasonable doubt that many of the large group of professional finders . . . are deliberately defrauding the people, and that the total amount of money they obtain is large.

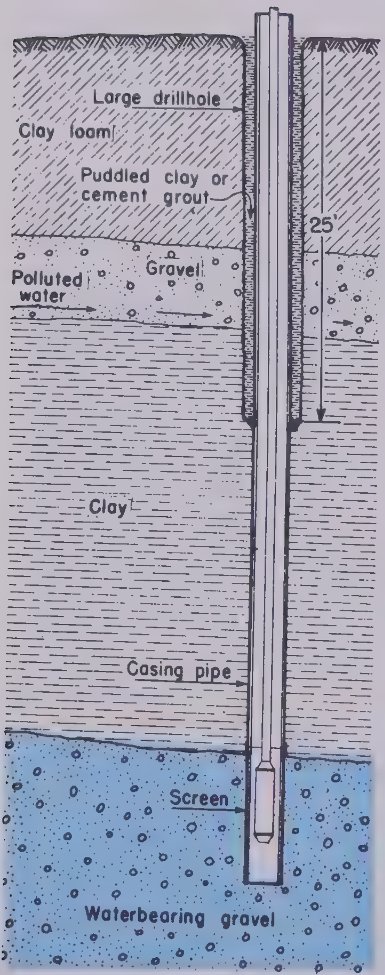
To all inquirers the United States Geological Survey therefore gives the advice not to expend any money for the services of any 'water witch' or for use or purchase of any machine or instrument devised for locating underground water or other minerals.'

How Can You Protect Your Well from Pollution?

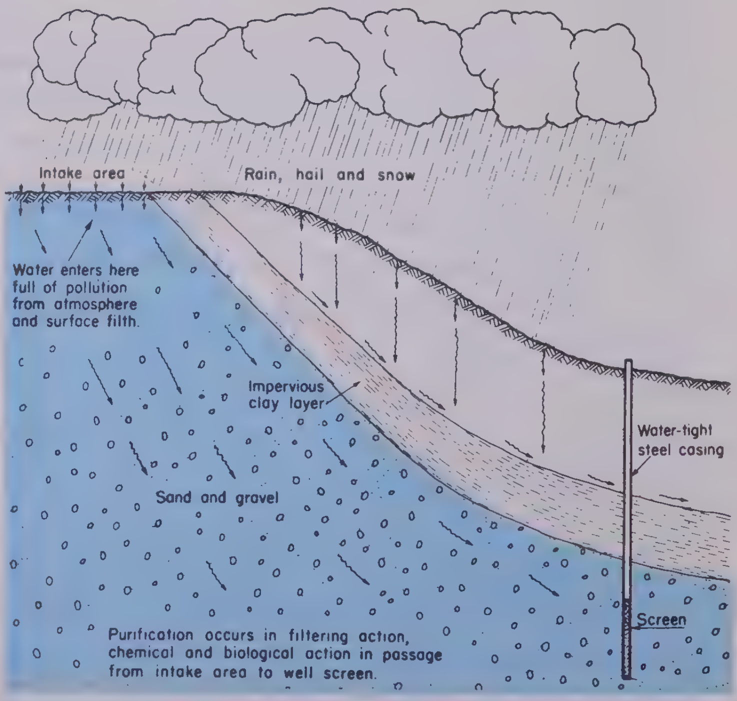
In order to have a completely sanitary and pure water supply certain precautions must be taken. First, the well should be drilled, as already stated, as far from sources of pollution as possible. The casing and other materials used in construction should be in good condition and installed in such a way that no surface water can leak down the outside of the casing to the aquifer (waterbearing zone). Ideally, at least the upper twenty feet of casing should be cemented into place, in order to be water-tight, and the casing should extend about a foot above floor or land surface.

A new well should be chlorinated, then pumped thoroughly to remove any bacteria introduced during drilling operations.

Rarely, well water is unsuitable because of bacteria, pollution, or laxative effects but before using water from a new well, it is advisable to have both bacterial and chemical samples taken and analyzed. Your local health unit office will supply containers and complete instructions for taking samples. The University of Alberta analyzes these samples free of charge as a public service.



All polluted water from surface or subsurface sources is effectively excluded from the well by deliberately establishing a large drill-hole and sealing the space between such drill-hole and the casing pipe with puddled clay or cement grout. Note how the well is finished in water-bearing gravel, where water purity is thoroughly protected. Use of a well screen assures maximum capacity output from the well.


Intake area
Rain, hail and snow
Water enters here full of pollution from atmosphere and surface filth.
Impervious clay layer
Sand and gravel
Water-tight steel casing
Screen
Purification occurs in filtering action, chemical and biological action in passage from intake area to well screen.

HOW THE EARTH PURIFIES WATER

What Should a Well Cost?

The total cost of a well cannot be determined in advance unless its exact depth is known. However, the driller can, and should itemize such costs as:

1. Cost of drilling, per foot or per hour.
2. Cost of casing, per foot.
3. Cost of other materals, such as screen, drive shoe, gravel pack, etc.
4. Cost of cementing.
5. Cost of developing, per hour.
6. Cost of test pumping, per hour.
7. Cost of pressure system or pump.

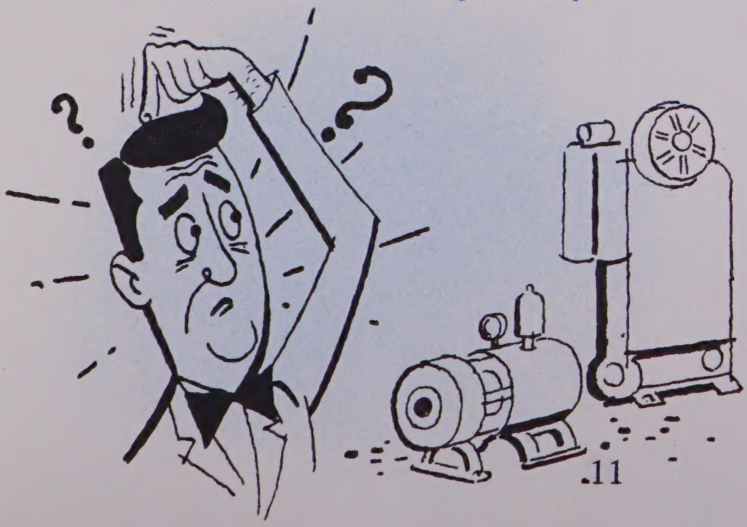
For a 100 to 200 foot well complete, the cost should be in the range of $1,000.00 to $2,000.00. This will vary, of course, depending on drilling conditions and length of time necessary for development.

A driller can cut costs if the customer insists, but only by cutting quality. In well drilling, as elsewhere, a cheap, slip-shod job costs more in the long run than a proper one initially.

Learning the Capacity of Your Well

Once the well is completed, its capacity should be tested. This is done by bail testing or pump testing, the test lasting one or two hours for a farm well. For large industrial wells, this should be extended to several days. In a bail test, a bailer containing a known amount of water is removed from the well at regular intervals. Each time, the water level and time of day is recorded. In a pump test, the well is pumped at a constant rate and the water level is measured at regular intervals. Both testing methods are satisfactory: the one used depends only on the type of equipment the driller has. By using the readings thus obtained, the competent driller can calculate the maximum safe yield of a well.

Selecting a Satisfactory Pump



The final step is to select a satisfactory pump. A large selection is available, and your drilling contractor or a pump company representative will help you choose the best for your own needs. The selection will depend upon:

1. Amount of water available.
2. Casing size (four inch minimum).
3. Pumping level.
4. Amount of water required.
5. How much you wish to pay. Some pumps cost less, but the manufacturer will not service or replace them. Others cost more, but in case of trouble, a replacement is provided immediately during repairs.

Summary

1. Estimate your total and foreseeable water requirements.
2. Hire a competent driller, agree on your financial arrangements, then place your confidence in his work.
3. Ensure that the well is free from the danger of contamination from sewage and bacteria.
4. Be willing to pay for a first-class job. It is the least expensive in the long run.
5. Pump test the well to ensure that it will meet your minimum requirements.